Oil & Gas Drilling User's Guide

Union®

A WireCo® WorldGroup Brand

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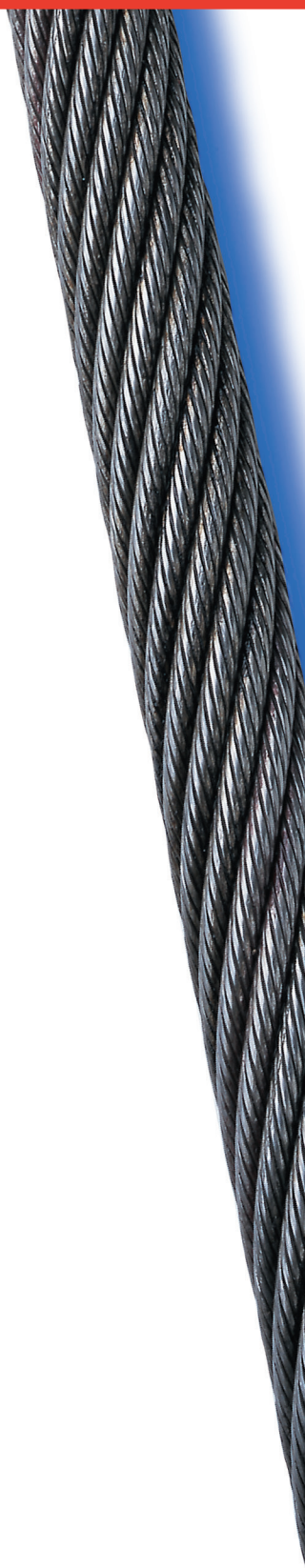
Let us show you the ropes.



It takes more than the right wire ropes to operate your rigs. It also takes the right knowledge and experience. When you know the ropes – that is, how to choose, use and maintain each of the many types of ropes – you'll know how to assure maximum service life and performance for each drilling application.

When it comes to showing you the ropes, no one does it like **Union**, a **WireCo WorldGroup** brand. We offer what you need for many different applications. And we offer the right experience to help you when you have questions, including how to help maximize your wire rope's service life and performance.

This *Oil & Gas Drilling User's Guide* is only one example. On the following pages, you'll gain valuable information to help you:

CHOOSE THE RIGHT WIRE ROPES
Knowing the ropes starts by understanding the wide variety of wire ropes available for the petroleum industry. This guide contains practical information as well as the recommended wire ropes to use for each application.

INSTALL WIRE ROPES Find out the proper procedures to install a drill line outlined in this useful guide.

INSPECT YOUR ROPES By regularly inspecting wire ropes, you'll not only know when to replace them, but also identify unusual wear patterns or abuse that could be caused by correctable conditions on the equipment.

EXTEND ROPE'S SERVICE LIFE THROUGH OUR CUT-OFF PROGRAM
By moving your drill line through the system so the wear is distributed more evenly, you can maximize your rope's service life. This guide reviews this proven practice.

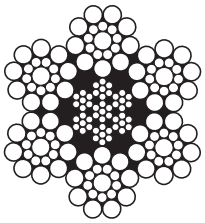
IDENTIFY AND PREVENT COMMON PROBLEMS IN THE FIELD This guide also helps you recognize and prevent some of the more common causes of wire rope problems in the field, including crushing, premature wear on the drum and spooling problems.

TESTED, TOUGH & TRUE™
At **Union**, we understand the oilfield market. Our years of climbing on the rigs with you, combined with the latest metallurgical practices and unique design capabilities, have enabled us to continue to innovate and provide the most cost-effective line of oilfield ropes in the world.

Union is part of the global leader in manufacturing, engineering and distributing wire ropes, synthetic ropes, wire rope assemblies, high carbon wire, and electromechanical cable: **WireCo WorldGroup**. We apply thorough design and manufacturing controls – including complete material traceability. And we are the only wire rope manufacturer in the world that is QPL qualified, API certified, and registered to both ISO 9001:2000 and AS-9100 Quality Systems.

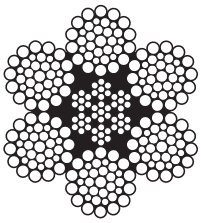
Buy the best:
Union – *Tested, Tough & True*

Choose the right wire rope for your application.



IF YOU NEED ABRASION RESISTANCE

> Abrasion resistance increases with fewer, larger outside wires per strand.



IF YOU NEED FATIGUE RESISTANCE

> Fatigue resistance increases with more, smaller outside wires per strand.

All wire ropes include a combination of characteristics that give them specific performance traits depending on design, engineering, materials and composition. With the many specialized procedures required for efficient well drilling, it is important to select ropes that are best suited for each application. No single rope can do it all.

DESIGN CHARACTERISTICS OF WIRE ROPE

Consider how the composition of a rope can affect its performance characteristics. A rope with fewer, but larger, outside wires per strand will deliver more **abrasion resistance** because of the greater rope surface area exposed to drums and sheaves. However, this most often results in a reduction of fatigue resistance.

A greater number of smaller outside wires per strand allows the rope to bend more freely which will **increase fatigue life**, but at the same time the smaller wires are more susceptible to abrasion.

Additional choices in design can modify these characteristics. You may choose a rope with more wires in each strand for **increased fatigue resistance** and with compacted strands, which will also provide **increased abrasion resistance**.

Choose the rope you need based on the type of operation to be performed. Different tasks demand different characteristics and the right rope for each task can be critical to the overall success of operations. The primary characteristics you will need to evaluate include several rope design characteristics.

> **FATIGUE RESISTANCE** Fatigue resistance involves metal fatigue of the wires that make up a rope. To have high fatigue resistance, wires must be capable of bending repeatedly under stress – for example, a rope passing over a sheave.

Increased fatigue resistance is achieved in a rope design by using a large number of wires. It involves both the basic metallurgy and the diameters of wires.

In general, a rope made of many wires will have greater fatigue resistance than a same-size rope made of fewer, larger wires because smaller wires have greater ability to bend as the rope passes over sheaves or around drums. To overcome the effects of fatigue, ropes must never bend over sheaves or drums with a diameter so small as to permanently bend the wires or rope. There are precise recommendations for sheave and drum sizes to properly accommodate all sizes and types of ropes.

Every rope is subject to metal fatigue from bending stress while in operation, and therefore the rope's strength gradually diminishes as it is used.

> **ABRASION RESISTANCE (Resistance to metal loss and deformation)** Metal loss refers to the actual wearing away of metal from the outer wires of a rope, and metal deformation is the changing of the shape of outer wires of a rope.

In general, resistance to metal loss by abrasion (usually called "abrasion resistance") refers to a rope's ability to withstand metal being worn away along its exterior. This wear reduces the strength of a rope.

The most common form of metal deformation is usually referred to as **"peening"** since outside wires of a peened rope appear to have been "hammered" along their exposed surface.

Peening usually occurs on drums, caused by rope-to-rope contact during spooling. It may also occur on sheaves.

Peening causes metal fatigue, which in turn may cause wire failure. The

hammering – which causes the metal of the wire to flow into a new shape – realigns the grain structure of the metal, thereby affecting its fatigue resistance. The out-of-round shape also impairs wire movement when the rope bends.

> **STRENGTH** Wire rope strength is usually measured in tons of 2,000 lbs. In published material, wire rope strength is shown as minimum breaking force (MBF) – referring to calculated strength figures that are accepted by the wire rope industry.

When placed under tension on a test device, a new rope will break at a figure equal to – or higher than – the MBF shown for that rope.

Minimum breaking force applies to new, unused rope. A rope should never operate at – or near – its MBF. During its useful life, a rope loses strength gradually due to natural causes such as surface wear and metal fatigue. Sudden loss of strength can be caused by abusive situations.

> **CRUSHING RESISTANCE** Crushing is the result of external pressure on a rope, which damages it by distorting the cross-section shape of the rope, its strands or core – or all three.

Crushing resistance therefore is a rope's ability to withstand or resist external forces, and is a term generally used to express comparison between ropes.

When a rope is damaged by crushing, the wires, strands and core are prevented from moving and adjusting normally during operation.

In general, IWRC ropes are more crush resistant than fiber core ropes. Regular lay ropes are more crush resistant than lang lay ropes. Six-strand ropes have greater crush resistance than eight-strand ropes or 19-strand ropes. Flex-X® ropes are more crush resistant than standard round-strand ropes.

> **STABILITY** The word "stability" is most often used to describe handling and working characteristics of a rope. It is not a precise term since the idea expressed is to some degree a matter of opinion, and is more nearly a "personality" trait than any other rope feature.

For example, a rope is called stable when it spools smoothly on and off a drum – or doesn't cause the ropes to twist together when a multi-part reeving system is used.

Strand and rope construction contribute to stability for the most part. Regular lay rope tends to be more stable than lang lay. A rope made of seven-wire strands will usually be more stable than a more complicated construction with many wires per strand.

There is no specific measurement of rope stability.

> **BENDABILITY** Bendability relates to the ability of a rope to bend easily in an arc. Four primary factors affect this capability:

1. Diameters of wires that make up the rope.
2. Rope and strand construction.
3. Metal composition of wires and finish such as galvanizing.
4. Type of rope core – fiber core or IWRC.

Some rope constructions are by nature more bendable than others. Small ropes are more bendable than big ones. Fiber core ropes bend more easily than comparable IWRC ropes. As a general rule, ropes of many wires are more bendable than same-size ropes made with fewer, larger wires.

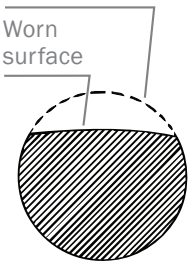
"SQUARED ENDS"

> Typical example of breaks due to fatigue.

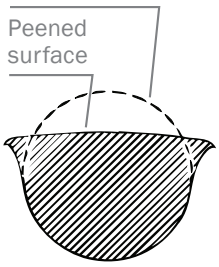
"CRUSHING"

> Typical example of external pressure on a wire rope.

CROSS-SECTION OF A WORN WIRE



CROSS-SECTION OF A PEENED WIRE



The right ropes for oil and gas drilling operations.

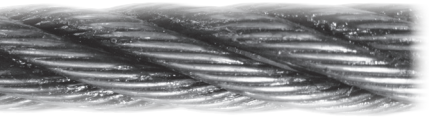
TYPICAL WIRE ROPES FOR ROTARY DRILLING OPERATIONS

The various lines for rotary drilling rigs require a complex balance of wire rope characteristics: abrasion resistance, crush resistance, fatigue resistance, strength, bendability and stability.

Each rig is different, of course, but the chart below provides general guidelines for selecting the right rope. For more specific recommendations, consult **WireCo WorldGroup Technical Support**: **816.270.4700**.

GUIDELINES ON VISIBLE CLEARANCE BETWEEN STRANDS*

> Clearances are designed between adjacent strands to allow movement when the rope is bent. In a new rope, because the strands have not pulled down to their tightest position, the clearances between strands are greater. A further



accentuation of this occurs as frequently the clearances accumulate between two strands instead of being equally divided among all strands. This will even out once the rope is placed in service. A final factor that makes the rope on a reel appear to have more clearance between the strands is because only the outside bend is visible and clearance is greatest on the outside radius of a bent rope.

This condition is normal and the rope should be used, maintained, inspected and retired per applicable standards.

**Wire Rope Technical Board, Technical Bulletin, Dec. 2006*

WIRE ROPES FOR DRILLING APPLICATIONS

APPLICATION	RECOMMENDED WIRE ROPE	COMMENTS
Rotary drilling line	Tuffy Balanced Drill Line 7/8" to 1-1/8" 6 x 26WS RRL IWRC 1-1/8" to 1-1/2" 6 x 19S RRL IWRC 1-5/8" to 2-1/4" 6 x 26WS RRL IWRC Above sizes and constructions available in TUF-KOTE® and TUF-FLEX®	This demanding application requires a rope that is abrasion resistant, crush resistant, fatigue resistant and relatively stable. Premium ropes may be used for specific applications. Tuf-Kote cushions the strands, distributes internal stresses, keeps in wire rope lubricant and keeps out dirt and debris, extending the service life. Flex-X ropes provide additional strength, more wear resistance, more fatigue resistance and more crush resistance.
Sand line	1/4" through 5/8" 6 x 7 RRL IPS FC	These ropes have larger outside wires to resist wear and help reduce costs.
Mast raising line	1-3/8" and smaller 6 x 19 class IWRC 1-1/2" and larger 6 x 36 class IWRC	Construction selected for balance of wear resistance and durability. Right regular lay or right lang lay is commonly used. Never mix right and left lay mast raising lines.
Air hoist Geronimo Tong line	6 x 26WS RRL IWRC	Better crushing and abrasion resistance than a 6 x 25 rope.
Derrick assist Block tie back	6 x 36WS RRL IWRC	Increased bendability and fatigue resistance.

TYPICAL WIRE ROPES FOR OFFSHORE OPERATIONS

Offshore rigs and cranes need wire ropes that rely on a different set of performance characteristics. Maintaining a stable platform in deep water, subject to constant battering by wind and waves, requires a system of powerful anchoring lines and tensioner cables with excellent bendability, fatigue and abrasion resistance.

On deck, wire ropes are needed to operate cranes, moving heavy loads to and from the rig with a minimum of maintenance and downtime. A variety of wire ropes are available for offshore cranes. The chart at the right describes some of the typical ropes, their usages and traits.

WIRE ROPES FOR OFFSHORE APPLICATIONS

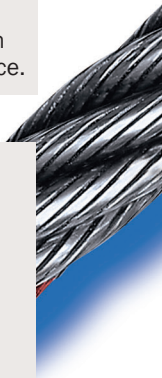
APPLICATION	RECOMMENDED WIRE ROPE	COMMENTS
Anchor line	6 x 19 class RRL bright or galvanized IWRC 6 x 36 class RRL bright or galvanized IWRC	Choice depends upon rope size required, drum geometry and other operating characteristics. The 6 x 19 ropes have larger outside wires for more abrasion resistance. The 6 x 36 ropes have a greater number of outside wires for extra bendability and fatigue resistance.
Buoy pendant	6 x 36 class RRL bright or galvanized IWRC	Offers good fatigue resistance.
Riser tensioner line (MRT)	6 x 36 class RLL IWRC 8 x 36 class RLL IWRC Flex-X® 6 MRT or Flex-X® 8 MRT	A lang lay construction is recommended because both ends of the rope are fixed and it is more resistant to fatigue than regular lay. Flex-X ropes increase strength and resistance to wear, fatigue and crushing.
Guide line tensioner line	6 x 26WS RRL IWRC	The 6 x 26 ropes provide a good balance between abrasion resistance and fatigue resistance.

WIRE ROPES FOR OFFSHORE CRANE APPLICATIONS

APPLICATION	RECOMMENDED WIRE ROPE	COMMENTS
Hoist	Category 1 rope Flex-X® 19 19 x 7 6 x 26WS	Provides the best rotation resistance, more lifting capacity and fatigue resistance. Flex-X 19 provides a great combination of rotation resistant properties and improved stability and resistance to crushing. Lower strength and less wear resistance than Flex-X 19, but does provide rotation resistance. May be used if block rotation is not a problem.
Boom hoist	Flex-X® 9 Flex-X® 6 6 x 26WS RRL IWRC	Flex-X 9 is designed to provide the resistance to drum crushing that is critical in many boom hoist applications. Flex-X 6 provides resistance to bending fatigue, as well as stability. Crane manufacturers specify a number of boom hoist ropes, but these are the most common. Check your owner's manual to assure ropes meet strength requirements.
Boom pendant	Rope or strand	Custom-fabricated to your requirements.

Another member of the WireCo WorldGroup family is CASAR. Our proprietary and innovative German-engineered rope designs deliver the highest levels of performance and safety, superior breaking strength values, the highest bending fatigue resistance, superior crushing resistance, and the best rotational resistance characteristics for high lifts.

For more information reference **www.casar.de**



Wire rope weights and minimum breaking force.

FLEX-X AND INCREASED SURFACE AREA

> Flex-X ropes provide greater surface area and more steel per given diameter, increasing rope stability, strength – and service life.

The 6 x 19 classification of wire ropes includes standard six round strand ropes with 16 through 26 wires per strand. The 6 x 36 classification includes standard six round strand ropes with 27 to 49 wires per strand.

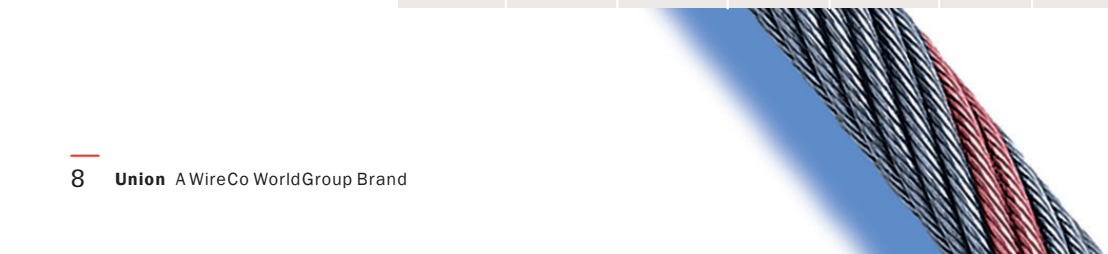
Although the physical characteristics of these two can vary widely, both have the same weight per foot and the same minimum breaking force, size for size. While 6 x 19 ropes have more abrasion resistance, the 6 x 36 ropes have more fatigue resistance because they have more wires per strand.

The Flex-X® process provides a smooth, extremely compact wire rope with greater surface area and more steel per given diameter, which increases strength, fatigue resistance and wear resistance.

When **Union's** Flex-X products are properly matched to the application, you'll get longer service life, lower operating costs and less wear to sheaves and drums.

WIRE ROPE MINIMUM BREAKING FORCE AND WEIGHTS

	6 X 19, 6 X 36 IWRC			TUF-FLEX® DL		FLEX-X® 9		FLEX-X® 19	
Diameter (in)	**Minimum Breaking Force XIP®** (tons of 2000 lb)	**Minimum Breaking Force XXIP®** (tons of 2000 lb)	**Approx. Weight** (lb/ft)	**Minimum Breaking Force** (tons of 2000 lb)	**Approx. Weight** (lb/ft)	**Minimum Breaking Force** (tons of 2000 lb)	**Approx. Weight** (lb/ft)	**Minimum Breaking Force** (tons of 2000 lb)	**Approx. Weight** (lb/ft)
1/4	3.4	–	0.116	–	–	–	–	–	–
5/16	5.27	–	0.18	–	–	–	–	–	–
3/8	7.55	8.3	0.26	–	–	–	–	8.3	0.3
7/16	10.2	11.2	0.35	–	–	–	–	11.2	0.4
1/2	13.3	14.6	0.46	–	–	–	–	14.6	0.5
9/16	16.8	18.5	0.59	–	–	–	–	18.5	0.7
5/8	20.6	22.7	0.72	–	–	26.2	0.9	22.7	0.8
3/4	29.4	32.4	1.04	–	–	37.4	1.3	32.4	1.2
7/8	39.8	43.8	1.42	–	–	50.6	1.8	43.8	1.6
1	51.7	56.9	1.85			65.7	2.3	56.9	2.1
1-1/8	65	71.5	2.34	71.5	2.5	82.7	2.9	71.5	2.6
1-1/4	79.9	87.9	2.89	87.9	3.1	102	3.7	87.9	3.1
1-3/8	96	106	3.5	106	3.7	–	–	106	–
1-1/2	114	125	4.16	125	4.5	–	–	125	–
1-5/8	132	146	4.88	146	5.2	–	–	–	–
1-3/4	153	169	5.67	169	6.1	–	–	–	–
1-7/8	174	192	6.5	192	7.0	–	–	–	–
2	198	217	7.39	217	7.9	–	–	–	–
2-1/8	221	244	8.35	244	8.9	–	–	–	–
2-1/4	247	272	9.36	272	10.0	–	–	–	–
2-3/8	274	–	10.4	–	–	–	–	–	–
2-1/2	302	–	11.6	–	–	–	–	–	–
2-5/8	331	–	12.8	–	–	–	–	–	–
2-3/4	361	–	14	–	–	–	–	–	–
2-7/8	392	–	15.3	–	–	–	–	–	–
3	425	–	16.6	–	–	–	–	–	–



Guidelines for installing and operating drill lines.

INSTALLATION

1. Use a rope connector grip (snake) with a swivel to connect the new drill line to the old drill line. This will relieve twist that may be put in the rope during spooling and handling.

2. Never weld the new drill line to the old drill line.

3. Try to install the new drill line at a point in the drilling operation when there is a considerable amount of weight available to help seat (break in) the new drill line and assist spooling.

4. Remove and inspect the brass inserts on the dead line anchor for proper size and if worn, replace. Rope must be seated properly in the clamp to avoid damage when torqued down. Torque the nuts on the dead line anchor clamp to the manufacturer's specifications. Torque should be rechecked after one to two hours of operation. (Refer to page 12 for inspection information.)

5. Special care should be taken during rig moves to prevent damage of the drill line such as kinks and doglegs.

OPERATION/SETTING CASING

1. The optimum service is received when the drill line operates with a design factor ranging from 5 to 7. A high design factor (over 7) wears the drill line out from bending fatigue because ton-miles do not accumulate as fast as at lower design factors.

2. The upper layer of the drill line can pull down through lower layers on the drum when setting heavy loads. This occurs because the block goes up empty with very little load. The drill line is not spooled tightly on the drum. The load is then applied to the drill line on the top layer which forces the wraps on the next lower layer apart allowing the top wrap to pull down. Using a heavier block or by adding "cheek" plates to the block will lessen the problem.

3. Rope service increases with fewer parts of lines. The fewer the number, the less rope is spooled on the drum so less rope is subjected to the crossover points on the drum. It also allows more rope available to cut. As an example, on a 7500' reel, if 12 lines are strung there is approximately 2200' of rope in the string-up or 5300' of rope available to cut. For 10 lines, there is 1900' of rope in the string-up, or 5600' of rope available to cut. This would increase rope service by over 5%.

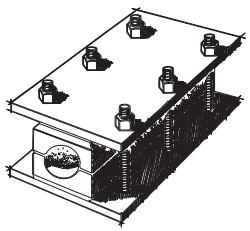
4. Always make a cut based on ton-miles accumulated prior to and after setting a heavy load of casing.

5. If the design factor for setting the casing is approximately 3.0, cut a minimum of 200' from the string-up. Inspect the remaining rope and make another cut if necessary.

6. If the design factor is down to 2.0 (the lowest allowed by API), cut a minimum of 600' from the string-up. After inspection, make another cut if necessary.

7. For design factors between 2.0 and 3.0, cut between 200' and 600'. Make another cut if needed after inspection.

8. Try not to install a new drill line (or slip all new rope into the system) just before setting a heavy load of casing. New or unused rope is more susceptible to crushing than a rope that has been in service.



BRASS INSERTS ON DEAD LINE ANCHOR

> Remove and inspect the brass inserts on the dead line anchor for proper size and, if worn, replace.

Rope must be seated properly in the clamp to avoid damage when torqued down.

Union provides excellent expertise in the field.

EXCLUSIVE CUT-OFF PROGRAM

While there are other cut-off programs available, contractors around the world consider the Union cut-off program as the best in the industry. Our computerized cut-off program calculates, logs, and tracks the service life of your Union drilling line. More importantly, it provides the tools to assure that you receive the maximum service life for your drill line. While the Union Cut-Off Program was originally developed more than 30 years ago to help our drill line users obtain the maximum service, we continually look for ways to expand and improve its functionality exclusively for our customers.

Our latest version of the cut-off program is available through a USB flash drive that can be plugged in directly to the USB port of any computer and is compatible with both Windows and Apple operating systems. This program is available in English, Spanish, Russian, and Portuguese, and you can choose your unit of measure as ton-miles, tonne-kilometers or megajoules. The program calculates the load and the distance lifted or lowered. You can set up a Ton-Mile goal and when that goal is reached, additional rope can be unspooled from the storage reel and slipped though the system. The used rope is then cut off and discarded. For an accurate record of the amount of work done by a drilling line, it is necessary to calculate the weight being lifted and the distance it is raised and lowered.

In order for the program to properly recommend when to make a cut and determine how much rope needs to be cut, the user must input a correct "Goal". This "Goal" should be entered as "ton-miles per foot cut", "tonne-kilometers per meter cut", or "megajoules per meter cut" depending on the units selected. Additionally, the program has certain goal limitations that it will not allow you to exceed and also will not recognize goals in the form of "ton-miles per 100 foot cut". For example, a slip and cut program of cutting 100 feet of rope after 1800 ton-miles have been accumulated will need to be entered as a Goal of 18 ton-miles per foot cut, not 1800. The Union Wire Rope team can help you determine the recommended goal for your specific rig based on information about your rig.

Union has the most qualified and dedicated team of engineers and sales professionals in the world. Their years of field experience, unmatched depth of knowledge and expertise sets the standard for our industry.

TECHNICAL TRAINING AND SEMINARS

Our experts conduct technical training for rig managers and tool pushers throughout the globe on a wide variety of topics such as installation, usage, rope inspection and retirement, and how to use our cut-off program. We can tailor our seminars to help you maximize the service life of your wire ropes. We are there for you.

Our expertise and experience can also provide invaluable assistance in the field. Our staff is available for rope inspections, on site consultation and problem solving.

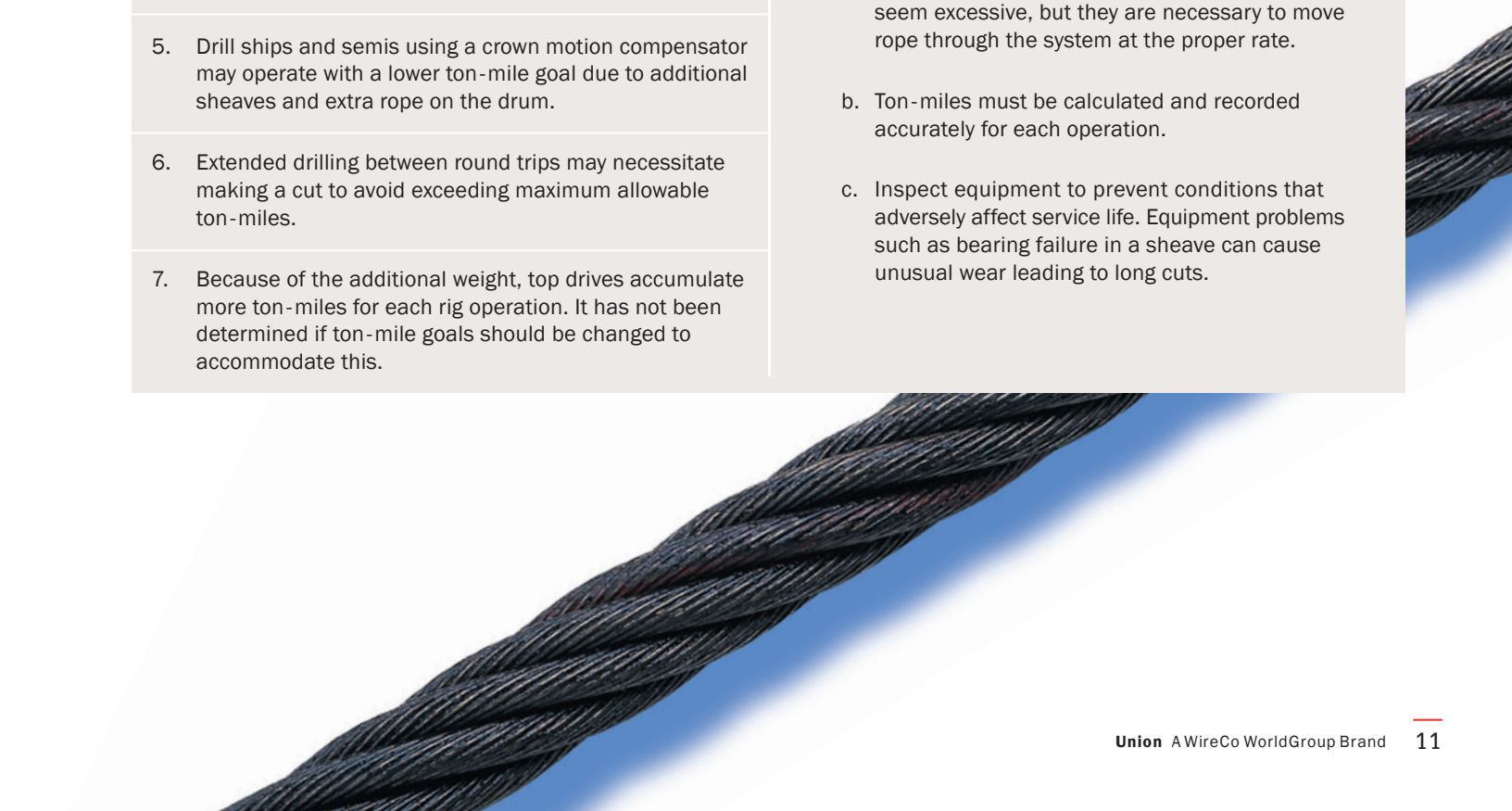
No matter where you are in the world, Union delivers hard-working products, exceptional service and unmatched support. At Union, we're with you in the field and on the rig, getting our hands dirty to supply Tested, Tough & True wire ropes that help you get the job done. Being part of the global wire rope leader, WireCo WorldGroup, ensures you can count on Union wire ropes for the toughest applications in your industry.

Guidelines for making drill line cuts.

Service life of drilling lines can be increased dramatically by following a planned cut-off program based on work performed. This moves the rope through the system so wear can be spread uniformly along the entire length of the rope, enabling the line to be removed from the drum end when it has reached the end of its useful service life. As the rope is cut off the drum end, new rope is fed into the system on the dead line side, extending service life. When exercising a cut-off program, follow the guidelines below closely.

A 10-STEP GUIDE TO A DRILL LINE CUT-OFF PROGRAM

1. For the first few cuts, wrap the drill line at the point being cut with duct tape prior to making the cut to prevent unlaying.
2. When making a cut and slipping new rope into the string-up, all of the wraps should be removed from the deadline anchor. The rope should never be pulled through a loosened clamp which can put a twist in the rope. The clamp should be completely removed and inspected. If worn or damaged, replace.
3. After making a cut, the dead wraps should be spooled on the drum with sufficient tension to prevent excessive drum crushing or “milking” of the bottom layer.
4. Take ton-miles for drag into account.
5. Drill ships and semis using a crown motion compensator may operate with a lower ton-mile goal due to additional sheaves and extra rope on the drum.
6. Extended drilling between round trips may necessitate making a cut to avoid exceeding maximum allowable ton-miles.
7. Because of the additional weight, top drives accumulate more ton-miles for each rig operation. It has not been determined if ton-mile goals should be changed to accommodate this.
8. Short, frequent cuts will shift critical wear points caused by excessive jarring.
9. Long cuts are necessary when the amount of rope to be cut doesn’t remove all the rope that meets removal criteria. This can be caused by failure to follow the ton-mile goal, improper calculation or recording of ton-miles. Damage at any point may require a long cut.
10. To prevent long cuts:
    a. Find the optimal ton-mile goal for your drill line; experience may indicate you have to change your ton-mile goal. It’s important to follow the cut-off program for a new rope. The first few cuts may seem excessive, but they are necessary to move rope through the system at the proper rate.
    b. Ton-miles must be calculated and recorded accurately for each operation.
    c. Inspect equipment to prevent conditions that adversely affect service life. Equipment problems such as bearing failure in a sheave can cause unusual wear leading to long cuts.



Make the most of your wire rope through regular inspections.

Despite their durability and strength, wire ropes will eventually wear out and must be removed after a period of use. That's why regular inspection is crucial.

HOW OFTEN TO INSPECT

All hoisting lines should be visually inspected at least once each day when in use, as is suggested by American Petroleum Institute (API) RP54 guidelines. Hoisting lines should be thoroughly inspected once each month and a record made of the monthly inspection.

Any wire ropes that have met the following criteria for removal must be immediately replaced. When in doubt, replace. The cost is minimal compared to what could happen if your rope breaks.

WHEN TO REPLACE RUNNING ROPES DUE TO BROKEN WIRES

Wire ropes used as running ropes other than sand lines should be removed from service when broken wires meet any of the following criteria:

> For six- and eight-strand constructions, replace when you see six randomly distributed broken wires within one lay length, or three broken wires in one strand within one lay length.

> For rotation-resistant constructions, replace when you see two randomly distributed broken wires in six rope diameters – or four randomly distributed broken wires in 30 rope diameters.

Sand lines should be removed from service when you see three broken wires within one lay length.

WHEN TO REPLACE STANDING ROPES DUE TO BROKEN WIRES

Wire ropes used as standing ropes such as guy lines, escape lines and pendant lines should be removed from service when any of the following conditions exist:

> Three broken wires are found within one lay length.

> More than one broken wire is found at the end connection.

> Broken wires are found in the valleys between the rope's strands.

WHEN TO REPLACE MAST RAISING LINES DUE TO BROKEN WIRES

> One broken wire is found anywhere along the length of the mast raising line.

OTHER REASONS TO REPLACE ROPES

Broken wires are only one way wire ropes wear out. Other conditions for removal of wire rope from service are:

> Corrosion that pits the wires.

> Corroded wires at end connections.

FOLLOW THESE STEPS TO INSPECT FOR VALLEY BREAKS

1. The first step is to relax your rope to a stationary position and move the pick-up points off the sheaves. Clean the surface of the rope with a cloth – a wire brush, if necessary – so you can see any breaks.
2. Flex the rope to expose any broken wires hidden in the valleys between the strands.
3. Visually check for any broken wires. One way to check for crown breaks is to run a cloth along the rope to check for possible snags.
4. With an awl, probe between wires and strands and lift any wires that appear loose. Evidence of internal broken wires may require a more extensive rope examination.

For additional information and requirements, please refer to the latest edition of:

> API RP 2D: Recommended Practice for Operation and Maintenance of Offshore Cranes

Typical valley (above) **and crown** (below) **wire breaks in outer wires.**

> API RP 9B: Recommended Practice on Application, Care and Use of Wire Rope for Oilfield Service

> API RP 54: Recommended Practices for Occupational Safety for Oil and Gas Well Drilling and Servicing Operations

> ASME B30.5: Mobile and Locomotive Cranes (crane rope removal criteria)

- End connections that are corroded, cracked, bent, worn or improperly applied.
- Evidence of kinking, crushing, cutting, bird-caging or a popped core.
- Wear that exceeds one-third of a wire's original diameter.
- Severe reduction of the rope's diameter.
- Evidence of heat damage.
- A significant increase in lay length.

HOW TO FIND BROKEN WIRES

One of the most common signs of rope deterioration is broken wires, normally the outside wires on the crowns of the strands.

RUNNING ROPES Because of their contact with sheaves and drums, running ropes typically receive heavier external wear than standing ropes. This can result in surface wire breaks – the easiest kind to locate during your inspection. The challenge is to find valley wire breaks. These may occur when ropes are used with small diameter sheaves, sheave grooves that are too small, heavy loads and other poor operating conditions. During your inspection, pay close attention to the areas of the rope in contact with sheaves and drums when loads are picked up. If there is a reason to suspect valley wire breaks, such as a reduction in rope diameter or elongation of rope lay, perform an inspection as outlined below for standing ropes.

STANDING ROPES Most wire breaks in standing ropes are internal (or valley) breaks that occur at the points of wire contact. Inspection will reveal no surface wear and therefore nothing to cause external wire breaks. The majority of broken wire problems on standing ropes occur near the end attachments or other points of restriction where vibration is dampened.

ROPE INSPECTION CRITERIA FOR DRILLING OPERATIONS

All portions of wire rope must be inspected thoroughly for possible deterioration on a regular basis. This starts with a close examination of the rope's critical points. The critical points of an application are those that subject the rope to greater internal stresses or greater external forces. Rope wear is more likely in the following critical areas, so it pays to closely inspect these areas:

DRUMS When the rope spools properly, normal wear occurs at the crossover, kickover and change-of-layer points. Look for scrubbing on the side of the rope; in other words, rope that rubs against the preceding wrap on the drum. Crushing may result on rope's top and bottom sides. If severe, remove the rope from service. Both the scrubbing and the crushing normally occur twice with each drum revolution.

Inspection of drums is also critical. Check for signs of wear that could damage wire rope. All drums should be smooth, not corrugated. Check for minimum number of dead wraps remaining on the drum, the spooling characteristics of rope and the condition of flanges.

SHEAVES It's very important to check for broken wires in the wire ropes traveling over the sheaves in your system. (See section on broken wires on facing page.)

Grooves tend to wear smaller over time, especially under heavy loading conditions. With a groove gauge, check each sheave for proper sizes, as well as their smoothness. Grooves that are too small or tight can cause pinching and increased abrasion while grooves that are too wide can cause flattening of the rope – both of which can reduce your rope's life. Also inspect for corrugation, broken or chipped flanges, cracks in hubs and spokes, signs of rope contact with guards, sheave bearings and shaft, an out-of-round condition, and alignment with other sheaves – all criteria for replacement.

END ATTACHMENTS Rope adjacent to end attachments has its movement restricted and is subject to fatigue as rope vibrations are dampened. Inspect with an awl to expose broken wires, and if more than one broken wire is found, replace the rope. Be sure to also inspect the fitting itself.

OTHER IMPORTANT AREAS TO INSPECT:

PICK-UP POINTS The sections of a rope that contact sheaves or drums when the initial load is applied.

HEAT EXPOSURE If an electric arc contacts the rope, remove the entire rope from service immediately. Although the problem may not be visible, electric arcs can affect the rope's properties and the rope needs to be replaced.

ABUSE POINTS Look for "bright" spots where ropes are subjected to abnormal scuffing and scraping.

How to identify and correct common rope problems in the field.

REDUCING CRUSHING AND SCRUBBING DAMAGE ON WIRE ROPE

CRUSHING When a wire rope crosses over the preceding layer on the drum, it is susceptible to crushing because there is only a single point of contact. This increases pressure and can result in damage by distorting the cross-section shape of the rope, its strands or core – or all three. Ropes that are new or not spooled onto the drum under tension are also more susceptible to crushing.

In addition, crushing may occur at the change-of-layer point where the rope is wedged against the flange of the drum.

SCRUBBING As the rope spools on the drum, it rubs against the preceding wrap at the kickover points, making the sides of the rope vulnerable to scrubbing damage. Scrubbing occurs most commonly when the rope runs into its preceding wrap in the same valley between two ropes on the lower layer. It can also occur as the adjacent rope comes into contact as a result of fleet angle.

FACTORS AFFECTING ROPE WEAR

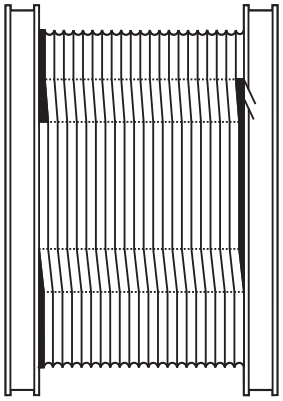
The degree of scrubbing and crushing damage depends on a variety of factors, such as rope construction, previous usage of the rope, the load on the rope, the drum diameter, the number of layers and the pitch of the grooving.

Single-layer winding on a plain-faced drum is more likely to produce an increased rate of wear to both the rope and drum compared to a grooved drum. Grooved drums control the position of the base rope layer, thereby reducing some types of spooling problems.

FIELD SOLUTIONS

If crushing is a problem on drill lines, one solution is to go to more parts of line to reduce the load in the wire rope. This will result in longer string-up and may cause less service from your drill line. If crushing proves to be a continual problem, drum modifications may help.

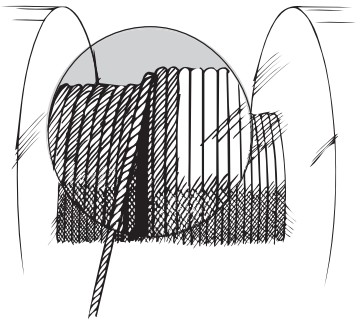
COUNTERBALANCE GROOVING



Counterbalance grooving has smaller displacement on the drum, which is less damaging at each crossover point compared to helical or parallel grooving. This reduces scrubbing problems at the kickover points as well as line "whipping." It also keeps the drum in balance by placing the kick-over points halfway around the drum from each other.

IMPROPER TENSIONING

Insufficient tensioning of the first two or three layers of rope can also cause rope wear by allowing "pulling in" by subsequent layers of rope. Without enough tension, these lower layers can be pushed apart by the upper layers. The upper layers then become wedged into the lower layers, which can distort the rope and/or individual wires.



WHIPPING

Rope whipping or vibration is another problem that may be encountered with high line speeds and multiple layer winding. Whipping is introduced by the lateral displacement or "throw" of the rope at the crossover points. When a wave is thrown into a rope by a crossover, this disturbance travels along the rope and is reflected back at the sheave at a speed relative to its weight and tension.

To reduce whipping problems, a line guide can be used between the drum and the crown sheaves.

Inspect your equipment.

IN ADDITION TO CAREFUL ROPE INSPECTION, PERFORM THESE EQUIPMENT INSPECTIONS ON A REGULAR BASIS.

1. Check the traveling block and crown sheaves. If the depth or size of the groove shows excessive wear, the sheaves must be replaced or repaired (especially the fast line sheave).
2. Check the lagging on the drum for size and smoothness. If excessively worn or corrugated, repair or replace it.
3. The kick back plates, kick back rollers and line guide roller assembly should be inspected periodically.
4. Rope should be removed from service if it meets the retirement criteria specified by API RP54.

INSPECT YOUR EQUIPMENT AND WIRE ROPE REGULARLY

> Inspection should be performed by a person with special training or practical experience.

Protect yourself

In the real world, accidents do happen, and that's why you need to take special precautions. Before installing wire rope in your applications, always read and follow the warning label attached to each product.

WARNING

Wire rope WILL FAIL if worn-out, overloaded, misused, damaged, improperly maintained or abused.

Wire rope failure may cause serious injury or death!

Protect yourself and others:

- ALWAYS INSPECT wire rope for WEAR, DAMAGE or ABUSE BEFORE USE.
- NEVER USE wire rope that is WORN-OUT, DAMAGED or ABUSED.
- NEVER OVERLOAD a wire rope.
- INFORM YOURSELF: Read and understand manufacturer's literature or *"Wire Rope and Wire Rope Sling Safety Bulletin"*.*
- REFER TO APPLICABLE CODES, STANDARDS and REGULATIONS for INSPECTION REQUIREMENTS and REMOVAL CRITERIA.*

* For additional information or the *BULLETIN*, ask your employer or wire rope supplier.

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NEED MORE INFORMATION?

> When it comes to oil and gas drilling, knowledge is your most important tool. We know this guide can't answer every question you have about wire rope.

If you have more informational needs, contact your **Union** distributor or district sales manager.

WARRANTY

Any warranty, expressed or implied as to quality, performance or fitness for use of WireCo WorldGroup products is always premised on the condition that the published strengths apply only to new, unused products, that the mechanical equipment on which such products are used is properly designed and maintained, that such products are properly stored, handled, used and maintained, and properly inspected on a regular basis during the period of use.

Seller shall not be liable under any circumstances for consequential or incidental damages or secondary charges including but not limited to personal injury, labor costs, a loss of profits resulting from the use of said products or from said products being incorporated in or becoming a component of any other product.

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